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the United States? Characteristic trees of different regions. Relation of water supply and forests. Control of erosion by forests. The effect of extensive cutting upon distribution of soil. Examples of excessive erosion and excessive deposition of soil.

2. Lumber camps: Sites chosen—reasons. Why winter is a good time for cutting and hauling. Transportation from lumber camp.
3. Saw mills: Situation; power used for operation; ways of preparing wood.

VI. Woods. Examine woodwork in the school room. Notice the different grain found. What is the grain of wood? Why do pieces of wood differ so much in grain? Examine small logs of different woods cut in cross, longitudinal and radial sections. Growth of wood—meaning of rings in the wood; green layer under the bark; injury caused by girdling trees.

It is not supposed that this outline can be carried out in all schools, but it is believed that many valuable lessons can be given along such lines of thought as are here suggested. The work as it stands is very comprehensive and is intended to be distributed throughout a course of nature study and geography.

A large part of this has been in use in the Horace Mann School in New York and has been found of great interest to the boys and girls, and it is hoped that such study in the schools will lay the foundation for an intelligent interest in the problems of forestry in the United States, and thus aid in checking the destruction which has already attained alarming proportions.

A NEW HYGROMETER SUITABLE FOR TESTING ACTION OF STOMATA

By D. T. MacDougal

Light, temperature, electricity, mechanical shock, moisture of the soil, salts in the soil, humidity of the air, winds, and prolonged darkness, exercise an influence upon the guard-cells of stomata in such manner that the pore is closed or opened when

any one of these forces acts with increased or decreased intensity upon the plant. The behavior of stomata to these factors is exceedingly various however. Thus some stomata open when the leaf is placed in water, while others close ; some stomata open in light, while others close under the effect of the sun's rays. Again, weak electric shock gives rise to one result, while a strong shock exercises the reverse action.

Any study of stomata by which their action is observed by means of a microscope will be vitiated with many errors, because in taking the epidermis from a leaf and mounting it for examination, stimuli are set up, which may cause the stoma to open or close before its original condition can be observed.

Practically all of the water given off by a leaf in transpiration passes through the stomata in the form of vapor, and the best method of ascertaining whether the stomata are opened or closed is to use some means of detection of watery vapor. This may be done in two ways, viz., by the cobalt method, in which paper saturated with cobalt nitrate placed on the leaf changes from a bluish to a reddish color in the presence of watery vapor; the second method consists in the use of a hygrometer. Several types of these instruments are in use in physiological laboratories. In one the variations in length of a strand of human hair with the changing humidity moves a lever carrying a pen which gives a constant record of the proportion of watery vapor in the air. This form has not been made suitable for testing the action of leaves. Another hygrometer consists essentially of an awn of some grass, like *Stipa*, which twists or untwists with the variations in humidity of the atmosphere. This type has been found very useful in some forms of investigation. A third form contains a thin strip of some material which curves and straightens with the varying humidity, and the best example of this type is the horn hygrometer of F. Darwin, in which the sensitive material is made of a thin strip of pressed horn. The simpler forms of hygrometer sold in the market for general use have a sensitive strip composed of two layers of material of different hygroscopicity, and the writer has devised one for testing the action of stomata which is based upon this principle. It may be made as follows :

Secure a straight piece of iron or copper wire 2 mm. in diameter and 25 cm. long, and bend a section 8 cm. long at right angles. Thrust this short arm through the axis of a cylindrical cork 15 mm. long and 8 mm. in diameter and bend the terminal 5 cm. at right angles and parallel with the long arm. Cut a strip from a developed film plate, such as are supplied by photographers, 8 cm. long and 5 mm. wide. Cut a slit in the cork parallel to the axis and thrust one end of the film in the slit. Now fasten a bristle 5 or 6 cm. long to the free end of the strip of film, which should have its convex surface uppermost. Bend the free end of the long arm of the wire upwards and at right angles, affixing a cork to the tip to which a suitable scale may be attached with glue (Fig. 1, *D*). Turn the cork on its axis until the strip would lie within 2 mm. of any surface on which the apparatus might be placed; note the position of the pointer, and place on the under surface of leaf which has been laid on a table upside down. If the stomata

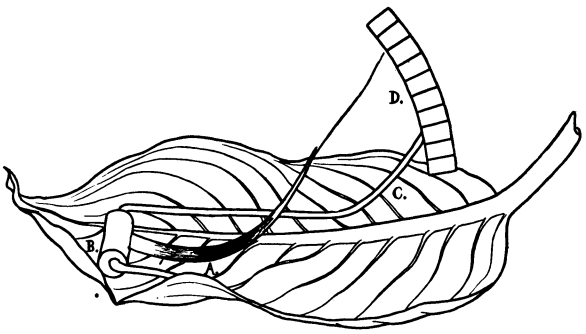

FIG. 1. Differential hygrometer. *A*, strip of film. *B*, cork. *C*, portion of wire bent upward to hold scale. *D*, scale over which the indicator has moved two divisions showing open stomata in the leaf on which the instrument rests. (Illustration from "A Practical Text-Book of Plant Physiology," by MacDougal, now in press. By permission of Longmans, Green & Co.)

are open the gelatine of the film will absorb watery vapor instantly and the strip will begin to straighten so that a movement of the indicator may be noticed inside of ten seconds. Set the hygrometer aside for a few minutes and place on the opposite side of the leaf. If it is free from open stomata no movement will be seen.

The instrument is extremely delicate and care must be taken not to blow the breath upon it while making a test, and the transpiration of the hand will give a decided reaction. Leaves attached to the plant may be tested both indoors and outdoors. It is believed that this instrument is free from most of the faults ascribed by F. Darwin to the horn hygrometer devised by him, and is quite as accurate and sensitive.

THE LYGODIUM AT HOME

By Frederick H. Blodgett

In Middlesex County, New Jersey, the climbing fern [*Lygodium palmatum* (Bernh.) Swz.] occurs in considerable abundance. The several localities are quite similar in general conditions, and a description of one will serve for an average of all.

The most accessible spot where it is found abundantly is a few miles south of New Brunswick, in the edge of the sandy area known as "the burnt woods." This is a tract of low hills and shallow hollows covered to a large extent with various scrub oaks and laurel. Many of the hollows contain water, either as nearly stagnant ponds, or as bogs of sphagnum and other aquatic plants. It is in one of these sphagnum bogs that the *Lygodium* grows.

Swamp maples and other water-loving trees surround the bog, giving place to the lower forms as the edge of the peat is reached, so that the surface of the sphagnum is nearly free from shade during the greater part of the day. Near the west end of the bog there are three colonies of *Lygodium*, a small one at the southwest, another at the northwest, and the third at the apex of a triangle, nearly equilateral, formed by the three. The fern grows among and entwines the low shrubbery and stout herbaceous plants forming the border of the sphagnum area of the swamp.

The largest colony is that in the northwest corner of the swamp. Here, on the 22nd of last December, the stems of golden-